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ABSTRACT

This report provides an overview of a series of studies testing the thesis that basic reading skill is a powerful mediating mechanism in social psychological explanations of pupil performances in a range of subject-matter outcomes of schooling. Basing analyses on the data base of the International Association outcomes of schooling. Basing analyses on data base of the International Association for the Evaluation of Educational Achievement (IEA), phase one of the study examined achievement in literature, phase two focused on the development of a prototypical model of school achievement, and phase three sought to extend and elaborate the general model. Progress so far, as well as work remaining to be done, is summarized in the report. (AA)

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FINAL REPORT

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HUMANITIES AND SOCIAL SCIENCES DIVISION

THE CANADA COUNCIL

BASIC READING SKILL AND SUBJECT-MATTER PERFORMANCE

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PREFACE

This project was planned to test the thesis that basic reading skill is a powerful mediating mechanism in social psychological explanations of pupil performances in a range of subject-matter outcomes of schooling. The project took-off from two previous inquiries by the first author, Achievement in Mother-Tongue Literature (1974), and Explaining School Performance in Literature (with Jeremy D. Finn, 1975) - both of which utilized a nationally representative probability sample of students from Swedish comprehensive secondary schools selected from the International Association for the Evaluation of Educational Achievement (IEA) Data Archive located at the University of Stockholm.

The co-investigators are grateful to the Institute of International Education, (IIE) University of Stockholm, for considerable assistance during the course of the project. First, there were additional data sets required for analytical purposes from England, India, and the United States which were provided by IIE. Secondly, there was the opportunity afforded through Clifton's award of a Spencer Fellowship (1976-77) and Bulcock's award of an Aspen Institute for Humanistic Studies Research Fellowship (1976-77), both tenable at the University of Stockholm, to further develop our ideas. Beebe's year in Stockholm was assisted by a part-time appointment as hemspråk (mother tongue) teacher in the Lidingö school district, and as research assistant on the evaluation of the bilingual science programme for English-speaking upper-secondary school students at the Norra Real School in Stockholm.

The first author wishes to thank the organizers of the International Reading Association's Sixth World Congress for the opportunity to present the first results from this investigation; and to the organizers of the Sociology

Association of Australia, and New Zealand (SAANZ) 1976 Annual Meetings who extended an invitation to share with them the second set of results from the investigation. Appreciation is also extended to the Australian National University for a visiting fellow appointment which made Bulcock's SAANZ meetings at[illegible]dance possible.

The first stage of the project was conducted at Memorial University where Bulcock teaches sociology of education in the Department of Educational Foundations; where Clifton shares a joint appointment between the Department of Educational Foundations and the Institute for Research in Human Abilities, and where Beebe has recently assumed a position as Assistant Professor in the Reading and Language Arts Division of the Department of Curriculum and Instruction. All investigators appreciate the generous research leave entitlement awarded by Memorial University of Newfoundland. The second stage of the project was conducted at the Institute of International Education, University of Stockholm. The facilities it offered and the atmosphere of dedication to educational research made it the ideal centre in which to further our inquiries into the oldest problem of educational research; namely, how come some children do better than others in the content fields of schooling?

It is important to note that although the present report finalizes the research for phase two and three of the research effort it is a final report only in the sense that the research project which was begun in 1974 has now gone through three phases, but the fourth and final phase is still incomplete. Since the research reported is part of a larger research design we regard the papers stemming from this phase of the total study as work-in-progress papers.

1. PHASE ONE RESEARCH: ACHIEVEMENT IN LITERATURE.

Phase one research began 1973-74 when the first author was awarded a Spencer Foundation Fellowship tenable at IEA, University of Stockholm, and ten months research leave by the Memorial University of Newfoundland. The research resulted in the Bulcock (1974) monograph dealing with achievement in mother tongue literature and a subsequent journal article by Bulcock and Finn (1974) on: "Explaining Performance in Literature".

These studies focused on the cultural and personality resources of secondary school students and their reading competencies as determinants of achievement in mother tongue literature. The research had several purposes. First, an attempt was made to construct a symmetrical model of literature achievement as a viable alternative to the asymmetrical or incremental "R" square approach used by IEA analysts, in which the impact of a variable was highly dependent on its order of inclusion in an equation composed of several blocks of variables. The IEA procedure was subsequently critized by Coleman (1975, 1976) who recommended the use of structural equation methods as an alternative procedure. A structural equation approach was used by Bulcock (1974) in his monograph in conjunction with a pooling procedure for adjusting correlation matrices in order to correct for the potentially confounding influences of extraneous variables.

The first purpose of the 1974 study was to use a path analytic approach in order to test a traditional model of achievement in mother tongue literature. Secondly, over-and-above the system variables suggested by conventional beliefs it was noted that the sex of the student and the amount of effort expended on school work might also account for variability in student performances. In order to control for their confounding influence a computer programme known as MULTIVARIANCE, written by Jeremy D. Finn of the State

University of New York, Buffalo, was used because of its inbuilt "pooling" technique which enables the analyst to control for the unwanted influence of potentially confounding variables.

Because it was the first time that one MULTIVARIANCE package had been used to solve a set of structural equations of the recursive variety while simultaneously utilizing the "pooling" technique, the programmer - Professor Jeremy Finn - expressed an interest in collaborating on a joint paper. In the subsequent Bulcock-Finn (1975) paper the substantive problem was addressed by Bulcock and the procedural one taken up by Finn in a technical appendix.

The analysis showed that the cultural resources of the student's home, and the student's verbal ability, as mediated by his reading comprehension accounted for nearly all the explained variance. Several conventional beliefs about literature achievement were not supported including the effects of reading speed, reading for pleasure, and attitudes toward literature.

Though suggestions were made regarding the functional respecification of the model in order to better handle attitudinal factors, the most important conclusion concerned the fact that all the variables accounting for mother tongue achievement were potentially manipulable via the exercise of within-class/within-school teaching strategies. Such policy relevance was in marked contrast to the orthodox findings of research utilizing conventional stepwise regression methods; which since the Equality of Educational Opportunity Survey (Coleman, et al., 1966) had found little variance in achievement outcomes attributable to school conditions or teacher variables. Hence, the question: "Does schooling make a difference?"

2. PHASE TWO RESEARCH: A PROTOTYPICAL MODEL OF SCHOOL ACHIEVEMENT.

It is to be noted that the IEA data archive located at the University of Stockholm provides the researcher in the modeling tradition with a hugh body of school achievement data. The data from 21 different countries consist of national probability samples of students at three age levels and in seven content field areas. Thus, there are greater opportunities for the application of inductive or incremental model building strategies with the omnibus-type survey instruments of the IEA variety than with most data sets.

It seemed to Bulcock at the conclusion of phase one research that several possibilities for further research existed. First, the preliminary studies showed the powerful explanatory force of verbal abilities and reading comprehension factors in micro-models of school achievement. Second, reviews of the literature dealing with reading comprehension and the content fields of schooling were practically nonexistent, suggesting the theoretical poverty of the field as well as the absence of systematic research. The fact was that although lip service had been paid to the importance of reading comprehension as a predictor of subject matter performance on a priori grounds, little extant research had addressed the question of: "How important?" Thirdly, the research conducted in phase one was suggestive of a prototypical model of school performance; namely, one in which reading strategies are used to intervene, or link, the home socializing environments and the personality traits of students with their motivational and attitudinal dispositions in a set of structural relationships designed to account for variability in the multiple scholastic performance outcomes of schooling.

These research possibilities could be examined utilizing IEA data archive sources. Thus, the Canada Council was approached as a possible

source of funding, and Memorial University colleagues Clifton and Beebe were invited to assist in extending the research base.

a. Study Number One: The General Model.

The first study was given the ambitious title: "Toward a General Model of the Structure of Scholastic Performance". (Bulcock, 1976) It built on the earlier research and eschewed the incremental R square approach altogether in favour of fitting symmetrical structured equation models. In this way functional specification errors were minimized. The central idea was the Thorndikes' (1917, 1973-74) postulate that: "reading is primarily an indicator of the individual's thinking and reasoning processes, rather than merely a set of distinct and specialist skills."

The research results provided convincing support for the thesis that verbal abilities and reading comprehension are powerful intervening variables between the pupil's family environment and his subject-matter performances in subject areas as logically distinct as literature and science. Support was forthcoming, then, for the notion of reading as reasoning as a common cause of the covariation between literature and science achievements. It was concluded further that the general model of scholastic performance placed in relief the significance of reading as a powerful resource asset of the individual; which intervened between the home environment experiences of children and their school dependent subject matter achievements.

This first study in phase two of the research used Swedish data. A national probability sample of Swedish 14 year-olds was selected from the IEA data archive in order to test the general model. Six specific findings are noted here.

(i) The use of asymmetrical research designs by earlier analysts seem to have overestimated home background effects as determinants of scholastic performance.

(ii) By the same token, use of the asymmetrical models had underestimated the effects of variables readily controllable by school authorities such as meaning vocabularies and reading comprehension.

(iii) Research procedures utilizing symmetrical designs for testing hypotheses based upon the thesis of personality resource conversion and focusing on the Thorndikes' postulate of "reading as reasoning" generated support for the postulate.

(iv) The variables reading comprehension, and verbal ability, had the most powerful total causal effects on literature and science achievements of the six independent variables constituting the model. Reading comprehension was the more powerful of the two.

(v) Significant sex differences in performance - the third most powerful predictor variable - were also noted. On the basis of extended analysis of sex differences it was concluded that the very process of achievement in science was different for boys than for girls, but that although girls out performed boys in literature the process of achievement was the same in literature for boys and girls.

(vi) There was little support for concluding as several analysts have done that some school subjects were more home dependent than others. Utilizing asymmetrical models it has become commonplace to note that reading and literature are more home dependent subjects than, say, science and mathematics. Though we are unable

to speak for mathematics, the fact is that in models in which the functional form is accurately specified there is no support for this common sense notion. If anything, science tends to be more home dependent than either reading or literature, but the differences are very small.

b. Study Number Two: Reading and Scholastic Performance.

The results from the "Toward a General Model of the Structure of Scholastic Performance" supported our general thesis about the role of reading comprehension in subject-matter performances at the secondary school level. In the course of testing the thesis, however, several conventional ideas about school achievement seem to have been seriously undermined. Clearly, replication as well as extension to the general model was desirable.

Replication and extension were the two major purposes of study number two entitled: "Reading in the Structure of Scholastic Performance". (Bulcock and Beebe, 1976). Beebe, a reading specialist, was invited to collaborate in order that the theoretical aspects of the "reading as reasoning" component of the study could be tightened and clarified.

A representative probability sample of English 14 year-olds was selected from the University of Stockholm IEA data archive for test purposes. Two considerations in the selection of English data were paramount. First, socioeconomic considerations have long been regarded in England as determinants of school performances. Indeed, much of the work in the structural-functional tradition in English sociology had emphasized the fact that a child's progress through school was as dependent on his social class origins as on his ability and motivation. Thus, it was expected that English data would provide a stringent test of the reading hypotheses. Second, English

scholars have made significant contributions to reading research. On the basis of this research reading instruction in schools begins earlier than in most countries - at age five instead of six as in Canada and the United States, or instead of age seven as in the Scandinavian countries and the Soviet Union. It was believed, therefore, that the Sweden/England comparisons would prove insightful.

As before, the Thorndikes' postulate was examined within the framework of a social psychological model of the structure of scholastic performance, and as before a symmetrical mode of analysis was preferred. This time, however, the underlying theory was more highly developed - reflective of Beebe's important contribution. It was argued following Goodman (1969) that the grapho-phonic skills taught by the reading teacher, plus the continued within-class development of the child's syntactic structures and semantic codes seemed to constitute the primary verbal reasoning processes. The development of these strategies involves the ability to react to what is read through checking validity, evaluating, making inferences, and drawing conclusions. It is this reading as reasoning which accounts for the differences in the subject-matter performances of a nationally representative sample of English 14 year-old students to a greater degree than any other known factor.

Earlier conclusions on the basis of the Swedish data were supported by the English analysis. Contrary to the findings of the structural-functionalists the socioeconomic circumstances of English secondary school pupils did not directly affect their subject-matter performances. Rather, background factors such as social class, parental education and family size were mediated by verbal ability and reading comprehension. In other words, background factors

affected subject matter achievements because they accounted for variability in psycho-linguistic skills and reading competencies which in turn affected achievement in literature and science. The importance of these indirect effects, however, should not be exaggerated. Both reading comprehension and verbal ability variables were more than twice as powerful as social class effects. Indeed, social class factors were only marginally more powerful than sex as determinants of literature and science performances.

Because our earlier Swedish research had shown the sex variable to be a powerful predictor of achievement in the content fields, even taking into account several other important variables, sex effects were given more deliberative consideration in the English replication. As before, girls out-performed boys in literature and boys out-performed girls in science. This time, however, it was shown that the process of achievement was not only different for girls, but also in aggregate more advantageous for girls. It was concluded that the advantages to boys in science were relatively less than the advantages to girls in literature, largely because the total effects of verbal ability on science performance were greater than those of reading comprehension in science performance and the verbal ability-science achievement relationship favoured girls. Thus, the sex differences in subject-matter achievements generated an overall net advantage to girls. In other words, English schools are moderately sex biased in favour of female students.

If one distingushes between "fixed" and "controllable" inputs in general models of scholastic performance - where the "fixed" inputs such as social class, family size and parental education factors are not manageable except at the expense of enormous societal effort - one must conclude from both the Swedish and English analyses thatthe "fixed" inputs are less powerful than the controllable determinants such as reading comprehension. The

research findings, using a model with a more accurately specified functional (or mathematical) form, were counter to those in an earlier analytical tradition, which promoted the conclusion that teaching in particular, but schooling in general, did not make much difference. Thus, the authors of the 1976 study using English data were able to conclude as follows.

(i) The thesis that the schools are class biased institutions in England did not hold up to close scrutiny in so far as subject-matter performances are concerned. Though socioeconomic factors were significant, their impact was several times less than that of more school manageable outcomes such as reading performance.

(ii) The fact that the academic performances of pupils are more controllable through within-school treatments than formerly believed, is interpreted as meaning that teachers, both individually and collectively, may legitimately assume greater responsibility for the intellectual efforts of students. The obverse of this coin supports the notion that teachers may be held more accountable for the quality of service provided for their clientele.

3. PHASE THREE RESEARCH: EXTENSIONS AND ELABORATIONS.

Phase three research has generated five papers (Bulcock, Clifton, and Beebe, 1976; Bulcock, 1976; Bulcock, 1977; Bulcock and Beebe, 1977; Bulcock, Beebe, and Clifton, 1977) which are largely extended and disaggregated versions of the general models tested in phase two of the research effort. Perhaps the major distinction between the procedural paradigms in the natural and social sciences is that between the use of "hard" data at a high information, low inference level used by experimental scientists, and the use of

"soft" data at low information, high inference levels used by social scientists dependent on the logic of the quasi-experimental design; that is, the design that relies more on statistical controls than experimental controls.

Phase two and phase three studies were in the "soft" modelling tradition. The tradition involves the identification of the structure of latent variables and their parameter estimation utilizing the correlations among measured variable indicators via covariance analysis; followed by the estimation of auxiliary models through the specification of a set of isomorphic structural equations containing these latent variables. The contributions of phase two studies to the overall research project may be summarized under four headings. First, the conceptual model was specified more accurately with reference to two explanatory schemes:- the socializing differences arguments, and the language factors argument. Secondly, an auxiliary model was specified embodying these explanatory frameworks. The variables father's occupation, parental education, family size or configuration, and sex, were connected to the socializing differences argument; and the variables verbal ability and reading comprehension related to the language factors argument. Thirdly, these variables were measured using the basic indicators available from the IEA data sets. Fourthly, the relationships between the measures were specified in a recursive path model consisting of a set of structural equations which were solved using regression analysis.

Phase three studies were largely extensions and elaborations of these four, stage two, contributions to the overall project. An important extension concerned the consideration of an additional argument. Subject-matter performance is not merely a function of socializing differences and

language factors. Rather, one must consider the arguments stemming from developmental psychology, and especially that school of thought centering on the research of Jean Piaget. Thus, the addition of a thinking stage factor added an important new dimension to the general model. Solutions to questions such as the following now became feasible.

(i) To what extent will the inclusion of a thinking stage variable attenuate the impact of "reading as reasoning"?

(ii) To what extent is the explanatory power of model increased by including the thinking stage factor?

(iii) Will the language factor's argument hold under the impact of a competing notion, or are the language factors and thinking stage arguments complementary?

In phase three research it became possible to disaggregate such gross school outcomes as science achievement into the more specific natural science outcomes - physics, chemistry, biology and practical work. In this way the extent to which factors stemming from the three basic arguments decompose covariation between the outcomes may be assessed. If subtest performances in science are accountable to a single set of causes, and if these common causes are controllable through within-class/within-school treatments, questions such as what to include in the school curriculum in order to achieve the goals of science education, are more readily answered than at present.

A third emphasis at the stage three level was the comparative one. A recurrent problem in educational research has to do with accounting for why poor people tend to do badly in school. One general explanation is based on the notion that the quality of thought and the cognitive style differs as between poor people and those not so poor. It is further argued that

traditional educational research is not able to address such problems because the tests used by psychologists can only identify quantitative differences, not qualitative differences, in performance.

If these explanations are correct the schools are merely penalizing children for the fact that they are poor; since distinctive styles of thought develop under conditions of poverty which are different from the styles developed by individuals raised under conditions of affluence. Moreover, if it is the dimensions of thinking or reasoning which account for the differences in school achievement, then controlling for these factors would severely attenuate the effects of being poor - that is, would attenuate the effects of the social class variable in our general model - which is precisely what happens. In the presence of reading as reasoning the direct effects of background factors were quite modest. Most of their force, in fact, was mediated by reading comprehension. When the thinking stage variable was added to the general model the background variables were attenuated further, such that their direct impact was effectively negligible.

By the same token, it has been argued that there are significant differences in cognition between different cultures (e.g. Gladwin, 1970). These differences are not so much concerned with the way in which information is organized, but rather with the way in which it is processed and manipulated; that is, styles of thinking and problem solving will differ from culture to culture, and especially when the cultures are widely discrepant. We have already noted significant cultural differences on the basis of sex differences in phase two studies. Thus, we have been able to conclude that the very process of achievement in, say, science is different for boys than for girls.

If the process of achievement is different between sexes in the same culture it seems probable that the process of achievement in, say, science

can be expected to be similarly discrepant as between different cultures. When we refer to the process being different, we are referring to the relative effects of the structural parameters of the explanatory model being different. We are not, however, referring to the models themselves being different; for example, we are not claiming that the structural elements themselves are different. Thus, we might note that the structural effect of the thinking stage variable in accounting for achievement in Chemistry is different in India than in England, ceteris paribus in both countries. This may be interpreted to mean that the relative impact of the structural parameter thinking stage - chemistry is different; that is, the process is different in one country compared to the other. Nevertheless, the logic underlying that structure of achievement is the same. The thinking stage variable is a logically necessary consideration in both nations. Even though its impact on chemistry may differ from one culture to the next it is still a vitally important operative element in the explanatory system of relationships accounting for performance in chemistry in both countries. Thus, different parameter estimates for the same set of relationships may lead one to the conclusion that the process of achievement in chemistry is different from country to country, but the elements in the system of relationships accounting for variability in chemistry performance are the same. These procedural differences are differences in style (e.g. style of thought) but not in kind; that is, they are not logically different in kind.

These notions, then, accounted for our interest in conducting comparative studies between culturally diverse countries. For comparative purposes we selected England as a highly developed industrial nation and India as a Third World nation. Culturally, historically, economically, and demographically, if not politically, the countries are quite dissimilar.

In sum, stage three research differed from stage two because: (i) the general model was extended through the inclusion of the thinking stage argument; (ii) the science (and theoretically the literature) outcome was disaggregated into the natural science subdisciplines; and (iii) emphasis was placed on comparative models.

a. Research Theme Number One: A Language Resource Model.

Though there have been five separate research reports and/or journal articles stemming from phase three research they are variants on two separate themes. Each theme is taken up separately. The first research theme was the concern of three of the papers (Bulcock, Clifton and Beebe, 1976, 1977, and Bulcock and Beebe, 1977), in which comparisons were made between England and India.

The research theme was related to the formulation and testing of a language resource model of science achievement. Two hypotheses were central. First, it was hypothesized that a child's primary resources in so far as cognitive development is concerned are linguistic skills. For a variety of reasons which we do not deal with systematically these resources can be assumed to be inequitably distributed. The inequity in psycho-linguistic resource distribution is especially noticeable by the time children reach school age. Second, it was hypothesized that the treatment settings of the school constitute opportunity structures wherein these primary resources are translatable into additional resources, foremost among which are reading competencies, which in the form of "reading as reasoning" may be interpreted as an important secondary resource. In the absence of structural constraints such as the provision of compensatory and special education a third hypothesis follows; namely, that the greater the primary and

secondary resources of the pupil the greater his aptitude for coping with the increasingly complex treatment settings provided by the school; and, further, the more effective these treatments the greater the probability that the individual will receive preferred treatments in the different settings provided at later stages in the educational/occupational cycle.

These hypotheses are merely restatements of the well-known cumulative advantage/deficit proposition with specific emphases placed on psycholinguistic resources. These resources - the primary ones being the verbal skills such as precocity in semantic, syntactic and graphophonic cueing strategies, and the secondary ones being reading precocity or "reading as reasoning" - constitute, we claim, the major common causes of the multiple subject-matter achievements (that is, the tertiary resources) of pupils in elementary and secondary schools.

In order to test these propositions we selected two sets of data from the IEA data bank archive at the University of Stockholm: Our familiarity with the English data set (Bulcock and Beebe, 1976) prompted our choice of a nationally representative probability sample of 14 year-olds from England. We wanted a comparison data set from a different culture for two reasons. In the first place we had received an invitation from the International Reading Association to present a paper describing our research at the Sixth World Congress; and the theme of the Congress was "reading in the Service of Mankind". Reading and its effect on achievement in the content fields in England can hardly be said to be representative of reading in, say, the developing world. Including a Third World country in our analysis helped to offset this discrepancy. Our major reason, however, concerned the desirability of testing hypotheses derived from the notion that the quality of thought and problem solving differ as between distinctive cultures. For

these two reasons we selected as our comparative data set a nationally representative probability sample of 14 year-olds from Hindi-speaking India.

The decision made we were faced immediately with three problems. First, we found that most girls had left school in India by the age of 14, or had hever been to school. For example, in the first level of schooling in India, standards 1 to 8 which correspond roughly to the age range 6 to 14 there were 72.65 million pupils enrolled in 1971 of which only 26.31 million were female; that is, 36 per cent. By the second level of schooling only about 1 in 4 of the pupils are female. The differences were even more marked in the IEA data for reasons we are unable to explain though we note that the India sample was restricted to public schools and excluded the private school sector which in India is well developed. We decided, therefore, to limit our analysis to boys only. The second problem was that in the India data, and to a lesser extent in the English data set, there were a number of pupils which fell outside the age parameters (14.0 to 14 years 11 months). These were also selected out of the sample. Thirdly, it was found that approximately 25 per cent of the remaining boys were functionally illiterate in India and 3 to 4 per cent in England; where illiteracy was conservatively defined as scoring 1 (one) or less on the reading comprehension test after correction for guessing. We decided to include only students who on the basis of this criterion were functionally literate.

There are other explanations of achievements in the content fields besides language resources. The socializing differences argument is one, which was dealt with in a cursory fashion in the discussion of phase two research. A second explanation is the thinking stage argument which is sometimes regarded as a competing thesis to that represented by the language resource asset or deficit theory. The competitive aspects of the two explanations

stem from the fact that the experts fail to agree about the role of language in the intellectual development of children. The most influential theory of cognitive development in both Western Europe and North America is that stemming from the work of Jean Piaget (1955) and colleagues (e.g. Piaget and Inhelder, 1969; Inhelder, et al., 1966). The Piagetian position holds that language ability is generally determined by the level achieved in cognitive development. It requires only a modest inferential leap to conclude that since language plays only a minor role in cognitive growth that encoding skills (for example, oral retelling, or writing) need not be emphasized in schools until much later than they tend to be at present (Furth, 1970).

In marked contrast to the Piagetian view, however, is that stemming from the seminal work of Vygotsky (1962) which has received impressive support from Bruner, et al. (1966), Kohlberg, et al. (1968), and Luria and Yudovich (1971). The Vygotski position holds that while verbal thought is a function of nonintellective speech and nonlinguistic thought, the two interact in mankind to generate an entirely new element of intellectual behaviour. Inferences from the Vygotskian position are diametrically opposed to those stemming from the Piagetian position. Thus, advocates of the Vygotski view hold that the most appropriate way to stimulate cognitive development is to promote the language development of young children. It only remains to point out that the failure to resolve these theoretical dilemmas will engender further confusion among educators, psycho-linguists and the like.

In addition to the cross-cultural perspective, and the inclusion of the Piagetian argument, the general model was further modified through the utilization of a disaggregated science achievement outcome. Thus, in addition

to examining the impact of factors suggested by three distinct arguments on science achievement, their simultaneous impact on achievements in physics, chemistry, biology, and practical work was also considered.

Without going into the analytical details presented in our technical reports and journal articles, we can summarize our purposes and state our conclusions related to research theme number one in phase three of our research in point form. Thus, we attempted six things.

(i) We were conscious of the necessity of revising and extending the general model of the structure of scholastic performance which had been tested in phase two of the research.

(ii) In particular, in phase three, we wished to stress the notion of reading as a school dependent language resource which is readily convertible in classroom treatment settings into additional desired scholastic performances. Language resources in their primary and secondary forms represent the major mechanisms accounting for the acquisition of intellectual resource assets or the lack there-of.

(iii) We believed that the language resources notion could best be demonstrated in the limiting case by examining their effectiveness as predictors of the science achievements of secondary school boys in physics, chemistry, biology and practical work because according to the conventional wisdom science is a school-dependent resource. If our thesis is correct then the covariation between the natural science outcomes will be accountable in some measure to the limited set of common causes suggested by three theoretical arguments.

(iv) We have argued that despite the tendency for the socializing

differences, language resource, and thinking stage arguments to be framed in competing terms, they are likely to be complementary rather than competing explanations of performances in the content fields. For example, the notion has been held that social class factors are more likely to determine the progress of the student through school in Western nations than such meritocratic considerations as aptitude and motivation. Similarly, it is often held that language ability is determined by cognitive development and not the other way round.

(v) We attempt to assess the relative impact of each of the three underlying arguments. For example, we try to assess the extent to which reading translates the unequal socioeconomic resources of children into unequal natural science achievements.

(vi) Finally, we attempt to examine cross-culturally the thesis that styles of thought and problem solving differ between different cultures.

It was concluded, first, that the socializing differences argument was less defensible in India than England. The extreme socializing differences argument held by some revisionist scholars (Bowles and Gintis, 1976; Greer, 1972; Katz, 1968, 1971; Spring, 1972, 1975) that a child's progress through school is more a function of social class than ability and motivation was rejected. The fact was that language resources and thinking stage factors had effects on natural science performances of secondary school boys which were greater in magnitude in both England and India than social background factors.

Two ex-post-facto explanations of the negligible impact of social background factors in India on both reading and science achievements were con-

sidered. The first holds that by age 14 the impact of class has already operated so that boys with severe social handicaps will for the most part have withdrawn from school. Alternatively, those that were still in school may have been screened out of the sample by the imposition of a reading comprehension criterion. The second, and in our judgement equally persuasive, explanation distinguishes between what home circumstances are and what they do. If home background factors are proxies for home socializing treatments which differ from class to class, and if socializing treatments from one class to another in India are about the same, then treatment differences do not exist and their proxies ipso facto will not be measured variation in background factors. A variant of this theme holds that in newly literate societies some of the advantages that can be transmitted to children at home by literate and schooled parents familiar with what will be expected of their children in school cannot be transmitted because the first generation of literates simply does not exist. Thus, the advantages conferred on children because the parents will simulate at home selected classroom conditions, thereby providing opportunities at home for the children to learn and practice school related skills, will not be transmitted in those societies in the transitional illiteracy/literacy phase because a first generation literate society does not exist.

Language resource factors and thinking stage arguments were independently operative in accounting for science achievements. Thus, it was concluded that the three explanations of achievements in the natural sciences were complementary notions. The Piagetian claim that achievement in science was dependent on the attainment of formal operational thought was strongly supported in both countries. The test was a stringent one in that the Piagetian variable operated over-and-above the simultaneous consideration of five other variables.

Of these contenders, the language resource factors - meaning vocabulary and reading comprehension - proved the most powerful. Since the language resource arguments were traced to the work of Goodman (1969, 1970, 1972) and R.L. Thorndike (1973-74, 1973) it was contended that Thorndike's work in educational psychology and Kenneth Goodman's work in applied Psycholinguistics merit the same careful attention that educators have given to the work of Jean Piaget.

Finally, the results demonstrated that the general model as revised was a powerful explanatory scheme accounting for sixty per cent of the variance in the science achievements of 14 year-old boys in England and thirty six per cent of the variance in science in India. Nevertheless, the process of achievement was different in the different countries. Thus, we concluded that procedural differences did exist; that, therefore, the possibility that the style of thought accounting for science achievements in India was different from that in England should not be ruled out; but, nevertheless, the models were logically of the same kind. That is, the similarities between the operation of the general model in the two different societies clearly outweighed the differences.

b. Research Theme Number Two: Social Facts Governing Subject-Matter Achievements.

Two separate papers by the first author have dealt with the second theme of phase three research (Bulcock, 1976, 1977). Both papers have constituted replications of the theme one studies but there have been two differences. First, the analytical framework has been modified through invoking the Durkheimian notion of "social facts". Secondly, the cross-cultural theme has been extended as follows. It was argued following com-

parative research in cognitition stemming from a social anthropological tradition, that the process of thinking accounting for an understanding of science might be different in diverse cultures such as those in England and India. By the same token, it could be argued that the process of thinking - that is, the operation of our general model of scholastic performance would be the same in similar cultures even though socio-historical traditions are different. For these two purposes data from England and Sweden were used, since in terms of economic development the two countries are similar in many ways.

It was claimed that five social facts govern public understanding of subject matter achievements in secondary school. Fact one concerns the dependency of content field achievement on social class origins. Fact two concerns the dependency of content field achievement on the student's language resources - especially reading competency. Fact three is the failure of the experts to agree about the role of language in the intellectual development of children, where one view holds that language achievement is generally determined by cognitive development and the other holds the reverse of this. Fact four concerns the sex differences argument. Girls have greater language precocity than boys, hence their advantage in literature and boys outperform girls in science and mathematics. Fact five supports the notion that the logically different outcomes of schooling are accountable to a limited set of common causes.

We found little support for the class biased schools thesis in either Sweden or England with regard to performances in reading, literature and science. The direct effects of background variables on these outcomes were negligible and the total causal effects; that is, the direct plus the indirect effects, were quite modest compared to the effects of social class,

parental education, and family size ranged from fourth to seventh in rank order in accounting for literature and science performances in England and Sweden.

The language factors outweighed all other considerations in terms of magnitude of effect on both subject-matter outcomes. Thus, the total causal effects of meaning vocabulary and reading ranked in first and second place in both countries and were several times more powerful than the total effects of other variables. These results provided convincing support for the reading as reasoning argument.

The Piagetian thesis was also supported in both countries but the thinking stage/science coefficients in the 0.4 to 0.5 range were not overly deterministic, suggestive of the notion that cognitive achievements are not entirely dependent on the application of higher order thought processes. Thus, mere recall of information, the application of rules of thumb procedures, and even intuitive guessing may play a part in determining intellectual achievement.

Most important in connection with the thinking stage variable was the finding that in both countries both language and thinking stage resources are essential to success. Since these factors operate independently we interpret the results as supportative of both Vygotsky's and Piaget's theses respectively.

The effects of sex on literature and science were powerful. Girls are advantaged in literature and boys in science. In England, however, but not in Sweden, the girls were noticeably better in literature than the boys were in science giving the girls a slight net advantage overall.

In both countries the models accounted for over 60 per cent of the variance; hence, clearly supportative of the resource conversion thesis.

And the proportion of covariation between literature and science accounted for by the common causes generated by socializing, language resource, and thinking stage arguments was 81 per cent in England and 83 per cent in Sweden.

4. A BALANCE SHEET.

a. Some Accomplishments.

Three accomplishments will be referred to. First and foremost there has been the formulation of a prototypical model of scholastic performance. Even using crude survey data of the questionnaire variety we are accounting for over 60 per cent of the variance in secondary school achievement in science and literature in most countries. In Sweden, for example, the multiple R in literature was .814 and in science .811; and in England the mulitple R's were .794 and .795 respectively. Given that a portion of the residual in each model is attributable to measurement error as apposed to model misspecification, these models are approximating determinism. Though there is still some way to go, the authors are not aware of the existence of more powerful explanatory schemes in this research tradition.

Secondly, the models have been applied to data sets from nations as culturally diverse as England and India. It has been shown that the relationships between several predictor variables and natural science outcomes are different in culturally diverse nations; and that these interaction effects are particularly powerful in regard to the effects of social class and thinking stage. Thus, some of the claims of cultural anthropologists working in comparative psychology were vindicated. Nevertheless, only modest differences in parameter estimates were noted between India and England with

regard to the impact of reading comprehension and meaning vocabulary - the language resources - on natural science performances. In terms of science achievement, then, some universalistic parameter estimates may exist - reading comprehension seems to be one of them.

Thirdly, the model parameters have been estimated. It has been concluded that in all nations, despite the important differences, that all three explanations of science and literature achievements are necessary in order to gain adequate understanding of scholastic performance. In all countries, the thinking stage argument was more persuasive than the socializing differences argument, and the language resource argument was more persuasive than both of these. In fact, the relative effects of a child's language resources in all nations, regardless of the achievement outcomes examined, were more influencial than the child's socializing and thinking stage resources combined. It is noteworthy that the sex differences subargument of the socializing differences argument was generally more powerful in accounting for variance in achievement than was the social class subargument. As was noted with respect to cultural differences, the procedure of achievement tended to be different in important respects for each sex.

b. What Needs to Be Done?

One massive research undertaking remains. There are also a number of loose ends which need tidying up. The four loose ends which readily come to mind are for the most part procedural. First, there is the recursiveness question. To what extent are the outcomes simultaneously determined; that is, to what extent may it be assumed that there are no causal links between achievement outcomes? It is stretching plausibility too far to assume that achievement in one subject fails to stimulate achievement in another. As

has been pointed out elsewhere: "the proposition that achievement stimulates achievement seems almost self-evident". (Hauser, 1971). Nevertheless, the assumption has been made throughout this study that there are no causal linkages between the natural science outcomes, or between science and literature. To construct a reciprocal model - that is, one with a feed-back loop between outcomes - is clearly a high order of future priority.

Second, there is the question of linearity. An earlier hunch that the reading skill-science performance relationship is nonlinear still remains unexamined. In practical terms the notion that science performance may be of modest proportions until an unknown, but knowable threshold of reading performance (the inflection point in a second degree polynomial-type relationship) is attained seems worthy of investigation. The linear relationship is so strong, however, it is difficult to conceive of the explanatory power of the present equation being significantly boosted by the addition of a polynomial term.

Thirdly, the question of whether interaction phenomena are present over-and-above the effects of sex and cultural differences which have already been identified, deserves consideration. Such model refinements would not necessarily add to the credibility of the general model already developed, but might boost in modest fashion the model's explanatory power.

Fourthly, there is the possibility that the prototypical model was misspecified because important variables were omitted. Thus, attitude variables such as "liking science", or "liking school" may be worthy of some consideration. The model may be extended, too, by the inclusion of an academic motivation variable.

More important in our judgment than all this tinkering involving tidying-up loose ends is an indepth treatment of organizational effects; that is, just what it is about the schools and the teachers that influence achieve-

ment over-and-above those resources that the student brings to school with him. In view of the fact that the IEA surveys were designed to give this problem a high order of priority, it is surprising that it has been given so little attention.

Recent developments in methods of analyzing environment data of the omnibus variety provide the researcher with the statistical tools necessary to identify the latent structures of school settings. (Joreskog, 1970; Wold, 1975). Though the assumption that these latent structures are the same across nations, subject areas and school populations is usually made, the question has never been seriously addressed. Finally, the impact of these latent structures in the form of composite variables on pupil achievement, through estimating structural equation models containing these latent variables has seldom been attempted though the subject is of interest to the social science research community.

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APPENDIX

Abstracts of the following published papers are presented in this appendix. They appear in chronological order.

Bulcock, J.W. Achievement in Mother Tongue Literature: Some Strategies of Causal Analysis. Report No. 5, Institute for the Study of International Problems in Education, University of Stockholm, 1974.

This paper focuses on the cultural and personality resources of individuals and their school related skills as determinants of achievement in mother tongue literature. A path analytic approach is used to test a popular model of literature achievement which is applied to a subsample of Swedish 14-year olds selected from the data bank archive of the International Association for the Evaluation of Educational Achievement, University of Stockholm. Because the sex of the student and the amount of effort expended on school work accounts for variance in levels of performance over-and-above the causally interrelated system factors, it is necessary to control for the possibility of their confounding influence. Accordingly, a "pooling" procedure is used for adjusting the correlation matrix in order to account for the bias in the regression model which is attributable to these factors. The analysis shows that both the cultural resources of the student's home, and his verbal ability, as mediated by his level of reading comprehension account for most of the "explained" variance in the model. Some conventional beliefs regarding achievement in literature were not supported by the analysis. Thus, variables such as reading speed, the hours spent reading for pleasure, and literary attitudes, were shown to have negligible effects and were omitted from the final revised form of the model. Some limitations of the analytical model are referred to, implying the need for additional respecification of the functional form of the model; hence, further research. The final form of the simple four variable model, which accounts for almost half the variance, is composed of policy variables potentially manipulable by within-school teaching strategies. There is some discussion of the educational implications of the findings.

Bulcock, J.W. and Finn, J.D. "Explaining School Performance in Literature." Scandinavian Journal of Educational Research, 19, 1975, 75-110.

This paper focuses on the cultural and personality resources of individuals and their school related skills as determinants of achievement in mother tongue literature. A path analytic approach is used to test a popular model of literature achievement which is applied to a subsample of Swedish 14-year-olds selected from the data bank archive of the International Association for the Evaluation of Educational Achievement, University of Stockholm. Because the sex of the student and the amount of effort expended on school work account for variance in levels of performance over-and-above the causally interrelated system factors, it is necessary to control for the possibility of their confounding influence. Accordingly, a 'pooling' procedure is used for adjusting the correlation matrix in order to account for the bias in the regression model which is attributable to these factors. The logic of this procedure is developed in the appendix.

Bulcock, J.W., Clifton, R.A., and Beebe, M.J. Reading Comprehension as a Predictor of Scholastic Performance: Comparisons Between Models for Industrialized and Developing Nations. Proceedings of the International Reading Association. Sixth World Congress, Singapore, August, 1976.

It is postulated: (1) that reading in the Thorndikes' sense, as reasoning, is a function of the individual's verbal ability and stage of thinking; (2) that verbal ability and stage of thinking mediate the effects of family background factors and sex (source variables) on reading comprehension; (3) that reading, in turn, mediates much of the effects of both source variables and other predictors of reading on a range of logically different curriculum outcomes. These outcomes include scholastic performance in mother-tongue literature and science; where science achievement is further disaggregated into subtest performances in physics, chemistry, biology, and practical work.

Since reading is a school dependent resource, it is argued that the grapho-phonic skills taught by the reading teacher, plus the continued within class development of the child's syntactic structures and semantic codes seem to constitute the primary verbal reasoning processes. It is the formal within-school development of these reading strategies - involving the ability to react to what is read through checking validity, evaluating, making inferences and drawing conclusions - which accounts for the acquisition of both decoding and encoding fluency. Thus, reading as reasoning accounts for considerable variability in a range of subject matter performances simultaneously.

Propositions generated by such a conceptual model have been subjected to empirical tests in analyses conducted on nationally representative probability samples of 14-year olds from several countries. The data was selected from the data archive of the International Association for the Evaluation of Educational Achievement at the University of Stockholm. The results provide strong support for the conceptualized model referred to as the general model of scholastic performance.

Comparisons between national samples of 14-year olds in England and India are used in order to find tentative answers to three outstanding research questions: first, whether the relative effects of the structural parameters of models of scholastic performance for developing and industrialized nations are similar or different; second, whether the total causal effects (TCEs) of exogenous predictors, and the TCEs of reading comprehension as an intervening mechanism, are similar or different for the two samples; and, third, whether the societal effort required to modify or change scholastic performances through policy manageable variables - and especially reading comprehension as the potentially most manipulatable variable - is greater for developing than for industrialized nations, or vice versa.

Technical appendices deal with issues relating to variable construction, model formulation, and the functional form of educational performance models. Reference is made to the practical, as well as the theoretical implications of the findings; and suggestions are made for extending extant models of scholastic performance, and for examining elaborated versions of the models through application of disaggregating techniques.

Bulcock, J.W. and Beebe, M.J. Reading in the Structure of Scholastic Performance. Report No. 21, Institute for the Study of International Problems in Education, University of Stockholm, 1976.

The Thorndikes' postulate that reading is primarily an indicator of the general level of the individual's thinking and reasoning processes, rather than merely a set of distinct and specialized skills, is examined within the framework of a social psychological model of the structure of scholastic performance. It is argued that the grapho-phonic skills taught by the reading teacher, plus the continued within-class development of the child's syntactic structures and semantic codes seem to constitute the primary verbal reasoning processes. The development of these strategies involves the ability to react to what is read through checking validity, evaluating, making inferences, and drawing conclusions. It is this reading as reasoning which accounts for the differences in the subject-matter performances of a nationally representative probability sample of English 14-year olds, to a much greater degree than any other known factor. Thus, the research showed that reading comprehension is a common cause of science and literature achievements. The socioeconomic circumstances of English children did not directly affect their subject-matter performances; rather background factors were mediated by verbal ability and reading comprehension. Girls outperformed boys in literature and boys outperformed girls in science, but the evidence showed that the net disadvantage to girls in science was less than the net disadvantage to boys in literature. It was demonstrated that in England the "fixed" inputs of scholastic performances are less powerful than the controllable determinants such as reading comprehension; and that, therefore, teachers may be legitimately expected to assume greater responsibility for the scholastic performances of children than heretofore.

Bulcock, J.W. "Evaluating Social Facts Related to School Achievement in Sweden and England." Scandinavian Journal of Educational Research, 21, 1977, 63-96.

The paper addresses one of the oldest problems in the history of education; namely, what accounts for children's variability in school performances in the content fields. Five social facts which currently govern an understanding of the problem are identified as follows: arguments related to (1) socializing differences, (2) language factors, (3) thinking stage, and (4) sex differences; and a more recent notion (5) that the covariation between logically different-in-kind sugject-matter outcomes of schooling is accountable to a discrete set of common causes. Measurement models of the structural equation variety are formulated in order to confirm the specified relationships between system factors. Only the class-biased schools thesis stemming from the socializing differences argument was rejected; a finding which may compel some sociologists of education to return to the drawing board.

Bulcock, J.W., Clifton, R.A. and Beebe, M.J. A Language Resource Model of Science Achievement: Comparisons Between 14-Year-Olds in England and India. Report No. 24, Institute for the Study of International Problems in Education, University of Stockholm, 1977.

It is hypothesized that the child's primary resources in so far as cognitive development is concerned are linguistic skills which are inequitably distributed. The treatment settings of the school constitute opportunity structures wherein the primary resources are translatable into additional resources, foremost among which are reading competencies, which in the form of "reading as reasoning" may be interpreted as important secondary resources. Such secondary resource assets along with the child's primary linguistic resources constitute major common causes of the multiple subject-matter achievements of pupils in elementary and secondary schools. These hypotheses are used to account for the achievements in the natural sciences of nationally representative probability samples of 14-year-olds in England and Hindi-speaking India. Other explanations, however, are frequently invoked in order to explain performances in the content fields; therefore, two additional arguments - the socializing differences argument stemming from sociology, and the thinking stage argument formulated by Piaget and other developmental psychologists - were simultaneously taken into account in formulating a comprehensive explanatory model. Though the primary and secondary resources of the students in both countries constituted the single most powerful explanation of achievements in physics, chemistry, biology and practical work, the socializing and thinking stage arguments were independently operative; and, therefore, the three arguments might be legitimately regarded as complementary rather than competing notions. Some of the theoretical and practical implications of the findings were discussed.